Rain Caps and Horizontal Stacks

Notes:

Currently the below changes must be made manually in AERMOD. The latest version of the Implementation Guide[1] indicates that these procedures will be incorporated into AERMOD when the EPA approves the beta version of the POINTCAP and POINTHOR AERMOD options.

Rain Caps and Horizontal Stacks

In general, when a stack employs a rain cap, the exit velocity is set to 0.001 m/s. If the cap swings open when operational, then model the stack as if there were no rain cap. For a special rain cap called the Chicago style,[2] which does not inhibit the discharge of effluents, the exit velocity is computed based on the diameter of the cap itself. Also, the stack height may need to be adjusted accordingly.

When using AERMOD, setting the exit (vertical) velocity to zero prohibits the model from making the determination whether the plume is dominated by momentum or buoyancy and thus computing plume rise accordingly.[3] The method to overcome this problem is to allow a small velocity, say 0.001 m/sec.[4]

1) For stacks that ARE subject to building downwash:

   An effective stack diameter should NOT be used to simulate the restriction to vertical flow since the PRIME algorithms use the stack diameter which, in turn, is used to solve conservation laws. The user should input the actual stack diameter and exit temperature, but set the exit velocity to a nominally low value, such as 0.001 m/s. This approach will have the desired effect of restricting the vertical flow while avoiding the mass conservation problem inherent with the effective diameter method. This method is expected to provide a conservative estimate of impacts. Additionally, since PRIME does not explicitly consider stack-tip downwash, no adjustments to stack height should be made.[5]

2) For stacks that ARE NOT subject to building downwash:

   Use an effective stack diameter to maintain the flow rate, and hence the buoyancy, of the plume, while suppressing plume momentum by setting the exit velocity to 0.001 m/s. To prevent stack-tip downwash, apply the non-default option of no stack-tip downwash. The stack release height for capped stacks should be reduced by three actual stack diameters

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[1] AERMOD Implementation Guide, October 19, 2007 Revision.
[2] The Chicago style "cap" is actually a vertical extension attached to the outside of the stack tip with a gap between the stack and extension to drain away precipitation. When there is wind, it acts to block precipitation from entering the stack.
[3] If the stack gas temperature is greater than or equal to the ambient temperature, then it must be determined if buoyancy or momentum dominate. A crossover temperature (ΔT_c) is computed. If the stack gas temperature minus the ambient temperature exceeds or is equal to ΔT_c, the plume rise is assumed to be buoyancy dominated. Buoyant plume rise and crossover temperature are proportional to v_s raised to a positive power. If v_s is set equal to zero, no analysis can be done and thus there is no additional plume rise due to buoyancy. A small value for v_s doesn't add any measurable momentum but allows for a buoyancy-dominated plume to exist a portion of the time, depending on the stack and (varying) ambient temperatures, thus resulting in a plume rise due to buoyancy. (ISC User's Guide, Volume II, section 1.1.4.)
[4] AERMOD Implementation Guide, October 19, 2007 Revision.
Also:
U.S. EPA, 1993. Model Clearinghouse Memo 93-II-09. A part of the Model Clearinghouse Information Storage and Retrieval System (MCHISRS). Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.
[5] AERMOD Implementation Guide, October 19, 2007 Revision.

to account for the maximum stack-tip downwash adjustment.[6] No adjustment to stack release height should be made for horizontal stacks.[7]

Tilted Stacks

In rare cases, there may be a tilted stack. If it is unobstructed, the only modification is to adjust the (vertical) exit velocity: multiply the actual stack exit velocity by the cosine of the angle between the stack and the vertical. The stack height is, as usual, the distance between the stack tip and the ground, and the diameter is its actual diameter. If the stack is obstructed, the exit velocity is 0.001 m/s.

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[6] Ibid.
[7] Ibid